

## 50 Ohms: The Forgotten Impedance

Steve Lampen 8/27/12

If you play with coax, short for coaxial cable, you probably know this it is available in a number of different impedances. The most common is 75 ohm, like video cable or antenna cable, but in fact our products range from 32 ohms up to 124 ohms.

Why all these different numbers? It's not an accident of course, and there is a reason for each one. Today, we're going to take a quick look at 50 ohm coax cable.

Belden makes hundreds of 50 ohm cables, including a whole line of ultra-low loss versions (Belden 7805 to Belden 7977). The two largest versions (Belden 7976 and 7977) are shown in the photograph below. They are HUGE. The 7977 has a diameter of .600" six-tenths of an inch! This is the largest coax cable that we make.

But first of all, why 50, or any other number? The answer can be shown in the graph below. This was produced by two researchers, Lloyd Espenscheid and Herman Affel, working for Bell Labs in 1929.

They were going to send RF signals (4 MHz) for hundred of miles carrying a thousand telephone calls. They needed a cable that would carry high voltage and high power. In the graph below, you can see the ideal rating for each. For high voltage, the perfect impedance is 60 ohms. For high power, the perfect impedance is 30 ohms.

This means, clearly, that there is NO perfect impedance to do both. What they ended up with was a compromise number, and that number was 50 ohms.

You will note that 50 ohms is closer to 60 than it is to 30, and that is because voltage is the factor that will kill your cable. Just ask any transmitter engineer. They talk about VSWR, voltage standing wave ratio, all the time. If their coax blows up, it is voltage that is the culprit.

So why not 60 ohms? Just look at the power handling at 60 ohms - below 50%. It is horrible! At the compromise value of 50 ohms, the power has improved a little. So 50 ohm cables are intended to be used to carry power and voltage, like the output of a transmitter. If you have a small signal, like video, or receive antenna signals, the graph above shows that the lowest loss or attenuation is 75 ohms.

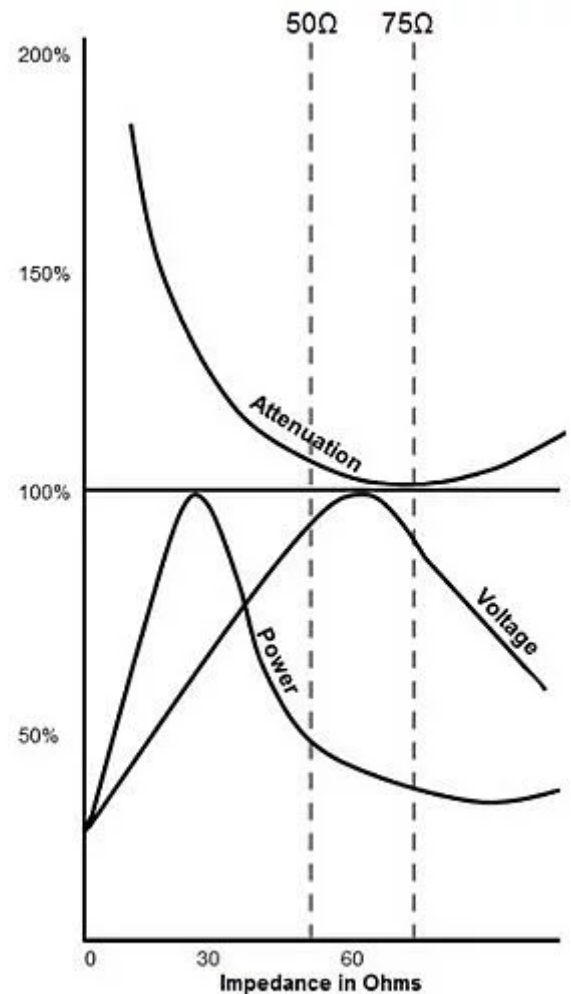
Still, I get a lot of feedback from people who use 50 ohms for small signals; you can see above that they are taking a 2-3 dB hit in attenuation. Excuses I hear are *"It's too late to change now!"* or *"That's the impedance of the box itself."* This is especially true of most test gear, which is universally 50 ohms. You have to buy a matching network to use it at 75 ohms or any other impedance. But there are lots of applications where 50 ohms is the best choice.

Belden 7977 mentioned above, can carry more than 5 kW at 30 MHz and more than 600 watts at 6 GHz. So even a cable this small could be used for TV or FM low power, boosters, translators, two-way radios, life-safety such as police/fire, RPU, many ham frequencies, microwave transmitters up to 6 GHz, and probably hundreds of other applications where signal are being delivered with high voltage and high power.

Most often, these signals end up in antennas. For instance, the sections in transmitters where small output power sections, like an exciter, are fed to a larger power section also require 50 ohm cable. That might be where the physically smaller 50 ohm cable might be used.

For many of these cables, they come in three versions: for outdoor applications, for riser-rated indoor applications, and for water-blocked applications such as direct burial or under-water applications. Some are even approved for shipboard ABS approvals.

These shipboard versions are also LSZH or low-smoke zero-halogen, which is often a requirement in some European countries. You can get more information and samples by contacting Belden customer service at 1-800-235-3361 (1-800-BELDEN-1) or just drop me a line at [steve.lampen@belden.com](mailto:steve.lampen@belden.com).



**Figure 2-8** Coax impedance and loss  
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